DOCUMENT RESUME

ED 127 137 SE 020 824

AUTHOR Gregory, John W.
TITLE Cornell Conditional Reasoning Test as an Adequate Measure of Conditional Moves in Adolescent Verbal Behavior.
INSTITUTION Florida Univ., Gainesville. Inst. for Development of Human Resources.
PUB DATE Jan 74
NOTE 36p.; Contains some light and broken type

EDRS PRICE MF-$0.83 HC-$2.06 Plus Postage.
DESCRIPTORS *Critical Thinking; *Deductive Methods; Elementary School Mathematics; Elementary Secondary Education; *Language Usage; Logical Thinking; *Mathematics Education; *Research; Secondary Education; Secondary School Mathematics; Verbal Development
IDENTIFIERS Research Reports

ABSTRACT

This research investigated the use of conditional language by students in fifth, sixth, and seventh grades on four types of tasks, and compared this usage with scores on the Cornell Conditional Reasoning Test (CCRT) and with the ability to recall information. One hundred thirty-two subjects were randomly selected from school populations, and randomly assigned to two treatment groups. Subjects in one group were given the CCRT and interviewed by the experimenter before performing four tasks; group two subjects were interviewed and tested after performing the tasks. Tasks used were: (1) providing free response explanations for four phenomena, (2) telling what might happen in a pictured situation, (3) stating a rule describing relationships depicted on cards, and (4) repeating a story read by the experimenter. All tasks were scored for the number of times subjects used conditional language. Data on individual tasks were analyzed and interpreted. Several analyses of variance were performed, and correlational data were examined. Significant effects for grade level and interview schedule were observed for both the tasks and the CCRT. For seventh-grade students, a significant positive relationship between task performance and CCRT scores was found. (SD)

****
* Documents acquired by ERIC include many informal unpublished *
* materials not available from other sources. ERIC makes every effort *
* to obtain the best copy available. Nevertheless, items of marginal *
* reproducibility are often encountered and this affects the quality *
* of the microfiche and hardcopy reproductions ERIC makes available *
* via the ERIC Document Reproduction Service (EDRS). EDRS is not *
* responsible for the quality of the original document. Reproductions *
* supplied by EDRS are the best that can be made from the original. *
****

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
NATIONAL INSTITUTE OF EDUCATION

THIS DOCUMENT HAS BEEN REPRODUCED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL NATIONAL INSTITUTE OF EDUCATION POSITION OR POLICY

ED127137

Cornell Conditional Reasoning Test as an Adequate Measure of Conditional Moves in Adolescent Verbal Behavior

By

John W. Gregory
Department of Secondary Education
Institute for Development of Human Resources
College of Education
University of Florida
Gainesville, Florida 32611

January, 1974

BEST COPY AVAILABLE

This research was performed pursuant to support from the Institute for Development of Human Resources.

SE020 824

Cornell Conditional Reasoning Test as an Adequate Measure of Conditional Moves in Adolescent Verbal Behavior

In 1972, Gregory found that there was a positive relationship between the frequency of conditional moves by teachers of seventh grade mathematics and their students' growth in conditional reasoning ability. One argument that has been given for this finding is that the teacher's language tends to shape the ordinary language of the students to conform to a more formal language needed to reason logically. If this is true, then the test of conditional reasoning ability which was administered in the Gregory study should also be measuring the degree to which the language of conditional logic is a part of student language. It therefore seemed appropriate to determine whether or not the Cornell Conditional Reasoning Test is an adequate measure of conditional moves in adolescent verbal behavior.

The data which was obtained in order to test the relationship between a student's score on the test and his use of conditional moves would also allow for consideration of the following questions:

1. Do differences in the use of conditional moves and in conditional reasoning ability exist between students in grades 5, 6, and 7?
2. Is the use of conditional moves or conditional reasoning ability of students in grades 5, 6, and 7 related to the ability to recall relevant information from an oral presentation?
3. Does the administration of the Cornell Conditional Reasoning Test have an effect on either the use of conditional moves or the ability to recall relevant information?

Hypotheses

The null hypotheses tested with an apriori alpha of .05 relevant to the objectives of this research effort, were:

1. There is no relationship between the frequency of conditional moves in responses of fifth, sixth or seventh grade subjects and their conditional reasoning ability as measured by the Cornell Conditional Reasoning Test.
2. There are no significant differences in the use of conditional moves or conditional reasoning ability between grade level groupings.
3. There is no relationship between the frequency of conditional moves or conditional reasoning ability and the ability to recall relevant information (Task IV).
4. There is no significant difference in use of conditional moves or recall ability between groups interviewed either before or after testing.

Population and Sample

Twenty-two boys and twenty-two girls from each of grades five, six and seven were randomly selected to serve as subjects in the investigation. The fifth and sixth grade subjects were selected from the total population of fifth and sixth grade students in a small elementary school. The seventh grade subjects were selected from the total population of seventh grade students enrolled in a middle school, both schools being located in Gainesville, Florida.

The plan of the study was to interview and administer the conditional reasoning test to all subjects thus identified. In order to determine the effect of the test administration on the language of the subjects, two treatment groups were formed.

The 132 subjects were randomly assigned to two interview groups. The "before test group" subjects were interviewed during the week prior to the test administration. The "after test group" subjects were interviewed during the week following the test administration. The initial composition of each interview group included 66 subjects; eleven males and eleven females from each grade level. The sex variable was not of primary concern but it was felt that the results of the investigation might lead to alternate hypotheses relative to sex differences which could be considered if this information was available.

Due to the absence of data for subjects on one of the two measures under consideration, the initial sample was reduced to 105 subjects. There was nothing to suggest that the elimination of these subjects was not random. The final sampling distribution is presented in Figure 1.

INSERT FIGURE 1 ABOUT HERE

Procedures

All subjects were interviewed individually by one of two trained interviewers in order to obtain a sample of each subject's verbal behavior. The subjects in the before test group were interviewed during the week

Figure 1. Sampling Distribution in the 3x2 Design

	Interviewed Before Test	Interviewed After Test	Total
Grade 5	n = 15	n = 22	n = 37
Grade 6	n = 16	n = 22	n = 38
Grade 7	n = 15	n = 15	n = 30
Total	n = 46	n = 57	n = 105

prior to the test administration. The after test group was interviewed during the week following the test. The interviews were scheduled in twenty-minute intervals over a three day period for each interview group. The subjects were interviewed in random order according to grade level, with the fifth grade being interviewed on the first day, the sixth on the second day, and the seventh grade subjects on the third day. The same procedures were used for both interview groups.

The Cornell Conditional Reasoning Test was administered to all subjects on the same morning. All fifth and sixth grade students enrolled in the elementary school from which the sample was drawn took the test under the direction of their individual teachers. The principle investigator was present for these administrations to assist as well as serve as a control for the directions given to the students by the teachers. The seventh grade subjects met in the school library for the test administration under the direction of the two graduate student interviewers. To guard against differences in test administrations, explicit directions were written and subsequently read to the subjects prior to the beginning of the test.

The Interview

Development of an interview format posed the greatest challenge for the methodology of the study. Since the coding system to be used was the same as that of a previous investigation, the types of responses to be coded as conditional moves were known. The coding system used was developed by Gregory (1972). A response made by the subject was identified as a conditional move if the language pattern used was of the traditional conditional logic form, "if p then q" although words such as "when,"

"as long as," "in order to," could be substituted for "if," and the word "then" did not have to be supplied. Rather than the specific form, the function of the move was considered to be of greater importance. The functions can be best described as follows (adapted from Smith and Marx, 1962):

1. Stating a result:

   The antecedent gives a condition and the consequent refers to what happens, what the result is, what the answer is, etc.

2. Stating an action:

   The antecedent gives a condition and the consequent refers to what has to be done, what should be done, etc.

3. Stating an identification:

   The antecedent gives a condition and the consequent refers to a classification, a definition, a name, etc.

4. Stating a quantification:

   The antecedent gives a condition and the consequent refers to length, length of time, rate, how many, etc.

Considering the function and a conditional paradigm similar to the "if...then" form, responses of the subjects were coded reliably as conditional moves.

A review of the research literature within the realm of child verbal behavior analysis through individual interview led to the discovery of several different techniques. The most common method of sampling the verbal behavior of children could be called free response. The subject is simply asked to answer questions posed to him by the interviewer. The questions are usually of the type for which there are no correct responses and the content congruent with the experiences of the subject.

A second technique has been referred to as "Aussage Psychologie." This narrative discourse method involves the presentation of a picture

of familiar content to the subject as a stimulus for verbal response. Brent and Katz (1967) utilized this method in a study in which they found a marked increase in "the ability clearly to verbalize causal and temporal relationships..." from the ages 6-7 to 11-12. Their success in describing language ability of students led to the consideration of this technique for inclusion in this study.

Another interview technique that has been used with great success has been task performance. Generally, the stimulus for student response is some type of manipulative. The manipulatives are presented in such a way that the subject is led to a generalization or statement of a rule. Since the conditional move has as one of its functions "stating a result," a subject may opt to use the conditional move to state a rule. For this reason, it was felt that having students state a rule from such a task would serve as a measure of adolescent use of conditional moves.

A method which has been used to measure both recall of relevant information and utilization of language configurations might be referred to as recitation. The subject is told that he is to listen closely to a story that will be read to hi[m] after which he will tell the story back. Since the results of this study [are] to be related to the study in which teacher use of conditional moves was found to be related to student growth in conditional reasoning ability, it was determined that the recitation task might serve as a measure of modeling. If the student used more conditional moves on a task in retelling a story that contained many conditional moves than on other tasks, the story could be considered as a variable which modifies verbal behavior. It has also been found, in a study by Rosenshine (1968) that student achievement scores on a test of relevant

material from a lecture were related to the teacher's use of conditional moves. It seemed appropriate therefore to consider relationship between the three variables of use of conditional moves, recall of relevant information from a recitation task and conditional reasoning ability.

With the discovery of these four techniques which had aided other investigators in obtaining adequate measures of adolescent verbal behavior, four separate tasks were developed, one for each technique. Before describing each task, it is important to note that it was hoped that each task would elicit conditional moves. At the same time, one guideline used in developing the tasks was to keep from forcing students to use a conditional move in his response. Analysis of the results reported later indicates that apparently the subjects did not feel compelled to use a conditional move as a result of the structure of the task.

A description of each task follows. A complete interview format is appended.

TASK I - Free Response

The subject was told that he would be asked several questions to get his opinions on some things. He was to answer each as best he could with the realization that there was no correct answer.

Four questions were selected from a total of sixteen which had been pilot tested. A question was selected for inclusion if students in the pilot had no difficulty in responding to it, if it was void of conditional moves as stated, and if some students used conditional moves in their response and some did not. The four questions retained were:

1) "Why is it better to put criminals in prison than to let them go free?"

2) "Why should a person keep a promise?"

3) "What's your opinion about boys with long hair?"

4) Why do you think women and children are the first people to be saved when a ship begins to sink?"

For partial or irrelevant responses, the interviewer probed further by saying "Fine, but can you explain a little more?"

TASK II - "Aussage Psychologie" Technique

A picture containing three obvious causal relationships was drawn for this task (appended). The subject was shown the picture and asked what he thought might happen. The interviewer probed for each of the causal relationships by saying, "What else might happen?"

TASK III - Task Performance

Two tasks were designed to have students observe and state a rule. In both tasks, the subject was shown a series of colored cards for which he was to guess whether a circle or square appeared on the reverse side. After the second, third, and fourth card was shown, the subject was asked to state a rule for finding the circle and the square. In the first set, there were two possible patterns observable: the circles and squares were on cards of different colors and the sequence circle - square - circle - square was used. In addition to different colors, the second set of cards differed from the first set in that they had either an A or B on the front. The task was the same; the subject was to state a rule for finding the circle and the square. This set however, had only one correct

relationship (the color). For each set of cards, the subject was asked to state the rule three times whether or not he had stated a correct relationship the first time.

TASK IV - Recitation

No appropriate story could be found that utilized a high number of conditional moves, so one had to be written (appended). Each of sixteen relevant parts of the story were stated using the conditional paradigm "if...then." Before reading the story, the subject was told to listen carefully because he was to tell the story back after it had been read. The only probing by the interviewer was to ask what the lesson of the story was if the student failed to state it.

An audio tape recording was made of each interview. Most students were aware of the microphone initially but it did not seem to alter their desire to respond.

Utilizing the coding procedures outlined above, the principal investigator analyzed each tape according to the frequency of conditional moves uttered by the subject. A reliability coefficient (intercorrelation) of .94 had been established for the coding of comparable tapes by the investigator and another trained coder prior to this analysis. Codings were registered for responses to each question in Task I, to the description in Task II, to each rule statement of Task III, and for the story recitation of Task IV. The number of sixteen relevant elements of information included in the recitation by the subject was also determined from the tapes.

It was thought that the maximum number of conditional moves possible for one interview session would be twenty-nine (4 for Task I, 3 for Task II, 6 for Task III, and 16 for Task IV).

The Cornell Conditional Reasoning Test

A form of the Cornell Conditional Reasoning Test (Ennis, 1964) was used to obtain a measure of conditional reasoning ability. This test of forty-two items requires an ability to apply seven principles of conditional logic by determining the truth-status of a given conclusion from given premises. It has been reported to have both high construct and high content validity. The reliability coefficient for the administration in this investigation was computed as .64.

Results

The interviews and test administrations led to the measures summarized in Table 1. Considering the mean frequencies of conditional moves for

---

INSERT TABLE 1 ABOUT HERE

---

individual Tasks I, II and III, the materials and task instructions did not compel students to utilize the conditional paradigm. It appears that those who used a conditional move in response to the tasks did so of their own choosing. What was surprising, however, was the erroneous assumption relative to the number of conditional moves possible. Task I still offered the opportunity for four conditional moves. But Task II rarely elicited the three conditional moves that were assumed would occur. The three

TABLE I. Mean Frequencies of Conditional Moves According to Interview Group and Grade Level

	Interviewed Before Test		Interviewed After Test		Total	
Grade 5	(n=15)		(n=22)		(n=37)	
	$\bar{X}$	S.D.	$\bar{X}$	S.D.	$\bar{X}$	S.D.
TASK I	2.06	1.38	3.13	2.18	2.70	1.95
TASK II	0.40	0.82	0.68	1.12	0.57	1.01
TASK III	0.73	1.03	0.64	1.53	0.67	1.33
Σ	3.00	2.33	4.45	3.54	3.87	3.15
TASK IV	3.40	2.03	6.23	3.36	5.08	3.19
TOTAL	6.53	2.97	10.68	5.35	9.00	4.94
REL. INFO.	5.60	2.72	7.91	1.57	6.97	2.37
CRT	13.07	2.08	15.41	4.54	14.46	3.88
Grade 6	(n=16)		(n=22)		(n=38)	
	$\bar{X}$	S.D.	$\bar{X}$	S.D.	$\bar{X}$	S.D.
TASK I	2.31	1.07	2.04	2.03	2.16	1.69
TASK II	0.69	1.07	0.50	0.59	0.58	0.83
TASK III	0.31	0.70	0.54	1.62	0.45	1.31
Σ	3.31	2.08	3.09	3.46	3.18	2.93
TASK IV	5.81	2.48	4.64	2.01	5.13	2.27
TOTAL	9.19	3.60	7.73	4.39	8.34	4.09
REL. INFO.	8.44	1.67	7.41	2.08	7.84	1.96
CRT	16.37	4.39	16.63	4.67	16.53	4.50
Grade 7	(n=15)		(n=15)		(n=30)	
	$\bar{X}$	S.D.	$\bar{X}$	S.D.	$\bar{X}$	S.D.
TASK I	2.87	2.07	3.80	2.56	3.33	2.34
TASK II	0.20	0.56	0.47	0.83	0.33	0.71
TASK III	0.40	0.63	0.40	0.91	0.40	0.77
Σ	3.47	2.29	4.67	3.08	4.07	2.74
TASK IV	3.53	1.92	5.60	3.68	4.57	3.07
TOTAL	7.00	3.04	10.20	6.06	8.60	4.98
REL. INFO.	6.20	2.17	7.67	1.95	6.93	2.16
CRT	18.66	7.43	17.79	3.65	18.23	5.78
TOTAL						
TASK I	2.413	1.55	2.898	2.31	2.68	2.02
TASK II	.43	.86	.56	.88	.51	.87
TASK III	.48	.81	.54	1.42	.51	1.19
Σ	3.26	2.19	4.00	3.42	3.68	2.96
TASK IV	4.28	2.40	5.48	3.05	4.95	2.84
TOTAL	7.61	3.37	9.46	5.30	8.65	4.63
REL. INFO.	6.78	2.50	7.66	1.85	7.28	2.19
CRT (42)	16.04	5.50	16.48	4.42	16.29	4.90

relationships inherent in the picture were usually stated in a single chain rather than three separate relationships. Instead of utilizing the conditional move for each relationship (e.g., "If the bull charges, the boy will let go of the rope. And if he lets go, the weight will fall. And if that happens then the girl will get squashed."), subjects using the conditional paradigm would usually respond by saying something like, "If the bull charges, then he'll let go and she'll get squashed by the weight." This occurrance tends to explain why the mean performances on Task II were less than 1.0 for every sub-sample.

Similarly, in Task III it was erroneously assumed that subjects were extended the opportunity to use a conditional move six times. Technically they did, but being practical, it seems that only two opportunities existed. Upon stating a rule for finding the circle and the square, the subject usually continued to use the exact same sentence structure (and most often, the exact same words) for the second and third statements of the rule. Therefore, for those subjects choosing not to use the conditional move, two opportunities existed. For those subjects using the conditional paradigm in response to this task usually did so incidentally to the rule statement or in the first statement of the rule only. This might be explained by considering the structure of the task. Upon stating a rule the first time, and implied acceptance from the interviewer by continuation of the task, the subject's first response was reinforced. Although further examples may have indicated that the rule statement was erroneous, at least the linguistic pattern used on the first statement had been accepted. Finding no subject who used a conditional move more than twice could be explained by this "statement-reinforcement" cycle.

Considering what happened in response to the first three tasks (Σ), instead of thirteen opportunities, it appears that there existed only seven for which subjects could choose to utilize the conditional move. The distribution of these seven would be four for Task I, one for Task II, and two for Task III.

To determine the significance of the differences between groups which are apparent in the data presented in Table 1, univariate analyses of variance were conducted for the use of conditional moves on Tasks I, II and III combined (Σ), on Task IV, on all four tasks (Total), for the recall of relevant information on Task IV (Rel. Info.), and for performance on the conditional reasoning test (CRT). A summary of these analyses is presented in Table 2. A significant effect is indicated for grade level (G)

INSERT TABLE 2 ABOUT HERE

---

on conditional reasoning test performance. Subsequent analyses of mean differences utilizing Newman-Keuls method (Winer, 1962) indicates that seventh grade subjects outperformed fifth grade subjects on the test of conditional reasoning ability.

A significant interaction between grade level (G) and interview scheduling (I) occurred for three of the five variables. Figure 2 presents

---

INSERT FIGURE 2 ABOUT HERE

---

a graphical representation of these interactions. Analyses of simple effects (presented in Table 3) can be summarized as follows: fifth-grade

TABLE 2. Summary of Univariate Analyses of Variance for Interview Groups (I), Grade Level (G), and Interaction (IxG).

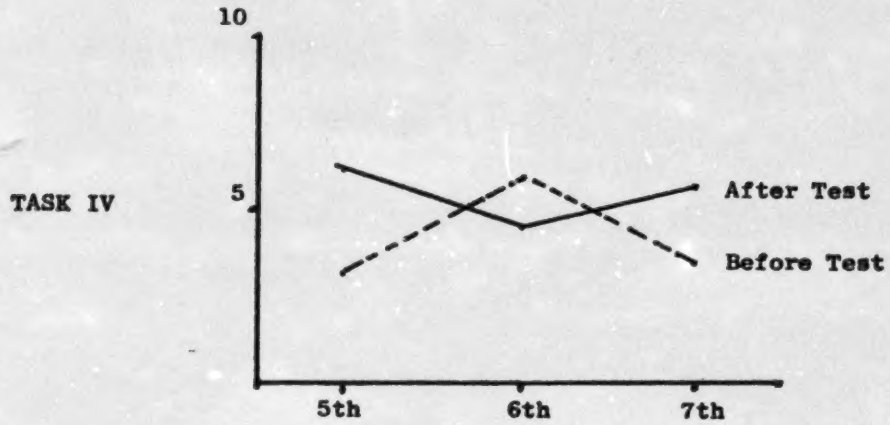
Interview Groups F(1,99)	ms.	F
	16.751	1.92
IV	39.108	5.42*
Total Cond. Moves	98.106	4.93*
Rel. Info.	21.359	5.18*
CRT	8.543	0.38

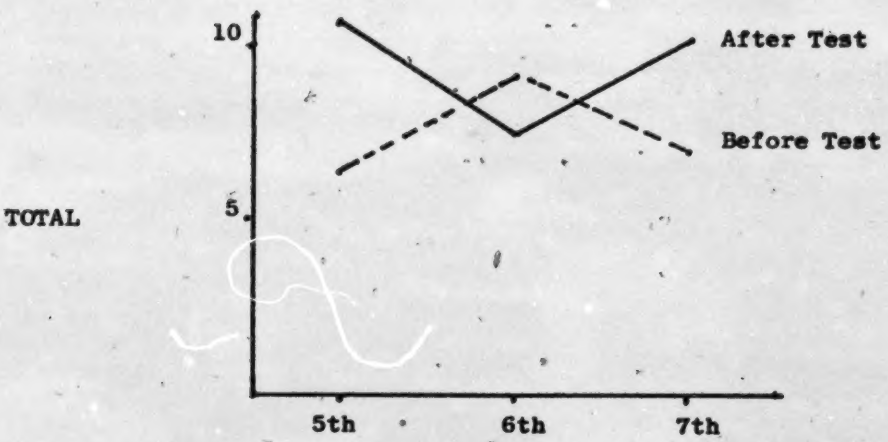
Grade Levels F(2,99)	ms.	F
	6.450	0.74
IV	3.749	0.52
Total Cond. Moves	0.242	0.01
Rel. Info.	13.461	3.26*
CRT	136.340	6.12*

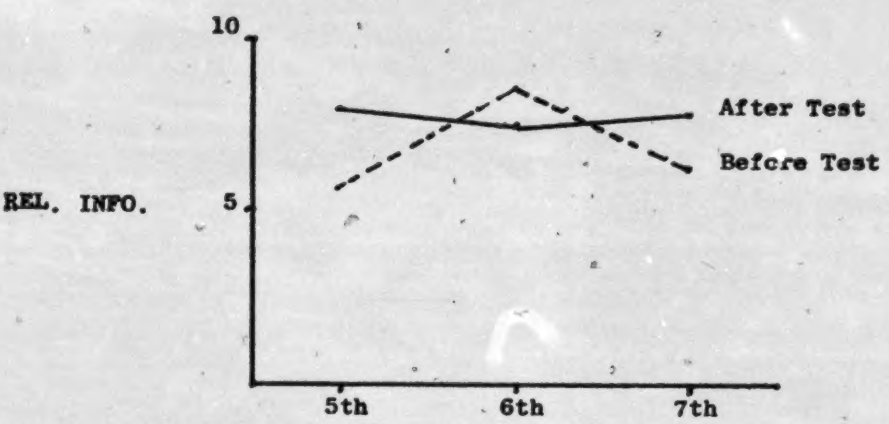
Interaction (IxG) F(2,99)	ms.	F
	6.924	0.79
IV	38.371	5.32*
Total Cond. Moves	76.506	3.84*
Rel. Info.	25.570	6.20*
CRT	22.492	1.01

*$p < .05$

Figure 2. Graphs of Significant Interactions







subjects interviewed after testing used significantly more conditional

INSERT TABLE 3 ABOUT HERE

moves on both Task IV and the entire interview and recalled significantly more relevant information on Task IV than fifth-grade subjects interviewed prior to testing. Significant differences were found for seventh grade subjects on the same variables with those interviewed after testing outperforming those interviewed before testing. The analyses presented in Table 3 also indicate significant differences between grade levels for subjects interviewed before the test. Once again Newman-Keul analyses were performed. For Task IV, the analysis indicates that sixth grade subjects used significantly more conditional moves and recalled significantly more relevant information than both fifth grade subjects and seventh grade subjects.

With the occurrence of significant interactions, relationships between variables would best be considered as they exist within I X G cells. Correlation coefficients presented in Table 4 indicate these relationships. Those of significance (both for this study as well as statistically) occur for seventh grade subjects interviewed after the test administration. The

INSERT TABLE 4 ABOUT HERE

relationship between use of the language of logic and conditional reasoning ability exists for this group only. The remaining significant correlations ($p < .05$) of interest are those expressing the relationship between the ability

TABLE 3. F-values from ANOVA of Simple Effects For Significant Interaction (IxG)

	IV	Tot. Cond.	Rel. Info.
I for G_1 (1,99)	9.432*	7.341*	10.981*
I for G_2 (1,99)	1.611	0.909	2.183
I for G_3 (1,99)	5.041*	4.364*	4.447*
G for I_1 (2,99)	5.499*	1.718	9.221*
G for I_2 (2,99)	1.508	2.136	0.257

*$p < .05$

TABLE 4. Correlation Coefficients Between Frequency of Conditional Moves, Relevant Information, and CRT for IxG Groups.*

Grade 5	Σ	IV	Total	Rel. Info.	CRT
	1	.2026	.7884	.1442	.0678
IV	-.2569	1	.7622	.6526	.2677
Total	.6084	.5662	1	.5056	.2130
Rel. Info.	-.4170	.7560	.2402	1	.0589
CRT	-.2351	-.0574	-.4207	.1183	1
Grade 6					
	1	.2372	.8958	.4298	.2786
IV	.1792	1	.6444	.6157	.0409
Total	.7452	.7874	1	.6201	.2380
Rel. Info.	.3400	.5029	.5613	1	.1918
CRT	.1897	.2635	.3028	.1576	1
Grade 7					
	1	.5786	.8630	.4071	.5335
IV	.0367	1	.9100	.7359	.7253
Total	.7763	.6585	1	.6762	.7017
Rel. Info.	.2372	.6552	.5920	1	.5160
CRT	-.0363	-.3066	-.2208	-.0618	1

*The values below the diagonals are correlation coefficients based on before test groups. Above the diagonals, coefficients are based on after test groups. Significant coefficients ($p < .05$) are underlined.

to recall relevant information and conditional reasoning ability as well as use of conditional logic language. Again the only existance of a significant relationship between conditional reasoning ability and ability to recall relevant information is for seventh grade subjects interviewed after the test administration. Recall ability is related to the total frequency of conditional moves in the interview for all but fifth grade subjects interviewed prior to the administration of the conditional reasoning test. The only existance of a significant relationship between use of conditional moves on Task I, II, and III combined and recall ability on Task IV was in the group of sixth grade subjects interviewed after the test. These relationships lead to qualified rejection of Hypotheses 1 and 3.

Conclusions

Hypothesis 1. There is no relationship between the frequency of conditional moves in responses of fifth, sixth or seventh grade subjects and their conditional reasoning ability as measured by the Cornell Conditional Reasoning Test.

This hypothesis is rejected with certain qualifications. A significant positive relationship existed between these variables only for seventh grade subjects who were interviewed after testing (Table 4).

Hypothesis 2. There are no significant differences in the use of conditional moves or conditional reasoning ability between grade level groupings.

Results of the analyses of variance (Table 2) leads to the rejection of this hypothesis. Significant effects due to both grade level and interaction of grade level with interview schedule exist. The posteriori

analyses indicate that seventh grade subjects scored significantly higher than fifth grade subjects on the conditional reasoning test and sixth grade subjects interviewed prior to testing used significantly more conditional moves on Task IV than either fifth or seventh grade subjects interviewed prior to testing. It is to be noted that these significant differences did not exist after testing nor for Tasks I, II and III combined (Σ) or Total Conditionals for these same groups.

Hypothesis 3. There is no relationship between the frequency of conditional moves or conditional reasoning ability and the ability to recall relevant information (Task IV).

Again a qualified rejection of this hypothesis is necessitated by the data analysis. No significant relationships exist between recall ability and conditional reasoning ability for the total sample. Considering the correlation coefficients for cell groups (Table 4), both Total Conditionals and conditional moves on Task IV are related to recall ability on Task IV for each group except fifth grade subjects interviewed prior to testing for whom the Total Conditionals variable was not related significantly. Conditional move frequency for Tasks I, II and III combined (Σ) is significantly related to recall ability only for the sixth grade subjects interviewed after testing ($\underline{r}$ = .4298).

Hypothesis 4. There is no significant difference in use of conditional moves or recall ability between groups interviewed either before or after testing.

Finding significant differences as a result of analysis of the interaction effect between before and after testing groups leads to the rejection of this hypothesis. Both fifth and seventh grade after testing groups outperformed the corresponding before testing group on Task IV (use of conditional moves and recall ability) and on Total Conditionals used. No significant differences were found between interview groups in the sixth grade. Therefore, this hypothesis is rejected.

Having attended to the apriori hypothesis, the results suggested a need for analysis relative to differences in verbal production on the tasks. The first three tasks were designed to elicit responses which would yield a measure of the subject's natural use of the conditional move. Task IV, in which the subject was to recall and retell a story containing a high frequency of conditional moves, sought a measure of the subject's tendency to model this linguistic structure. Two ratios were computed for each subject. The ratio of frequency of conditional moves to number of perceived opportunities (13) on Tasks I, II and III combined was the measure of natural use of conditional moves. The ratio of frequency of conditional moves to number of elements of relevant information related by the subject (maximum = 16) serves as the measure of modeled use of the conditional move. Table 5 presents the mean ratios for each IxG group. As this table indicates, the ratio of material use

---

INSERT TABLE 5 ABOUT HERE

---

is less than the ratio of modeled use for each IxG combination. The nature of the design employed is not appropriate for calculating significant

Table 5. Group Ratios of Conditional Move Utilization per Number of Possible Opportunities.

	Before Test	After Test	Total
Grade 5			
Task I, II and III	.45	.64	.55
Task IV	.62	.77	.73
Grade 6			
Task I, II and III	.47	.44	.45
Task IV	.68	.63	.65
Grade 7			
Task I, II and III	.50	.68	.58
Task IV	.57	.71	.66
Total			
Task I, II and III	.47	.57	.53
Task IV	.63	.72	.68

differences between these two measures, however, the data does suggest that modeling from the story might be taking place.

Interpretations

This study set out to determine whether or not adolescent use of the language of conditional logic is related to their conditional reasoning ability as measured by the Cornell Conditional Reasoning Test. The concern was an outgrowth of a study by Gregory (1972) in which seventh grade mathematics students' growth in conditional reasoning ability was found to be related to their teacher's use of conditional moves.

Although this relationship was not found to exist for fifth or sixth grade subjects it was found to exist for seventh grade subjects who were interviewed after taking the test. This seems to indicate that the test itself may have sensitized these subjects to the language associated with this basic logical reasoning type. This apparent test-effect is strongly supported with the finding of significant differences favoring the after test groups in utilization of conditional moves on the modeling task, on the entire interview and in recall of relevant information. This finding suggests that in future investigations of short duration, designs which lead to knowledge of the interactive effects of testing and student verbal measures should be employed. For our own work in the Florida Project, designs of this type need to be employed to establish interactive effects of testing and instructional verbal strategies on student outcomes, in view of the results.

From a child development standpoint, the results reaffirm what others have found, namely that there are significant differences in logical

reasoning ability between grade levels. The results also indicate that the common assumption that logical reasoning ability and language of adolescents are related may be in need of qualification. This investigation adds credence to hypotheses of others which suggest that adolescent logical abilities (test-wise as well as linguistic) are more egocentric than they are hypothetico-deductive.

Bibliography

1. Brent, Sander B. and Katz, Evelyn W. A Study of Language Deviations and Cognitive Processes. Detroit: Wayne State University, 1967.

2. Ennis, Robert H., et al. A Description of "The Cornell Conditional Reasoning Test, Form X." Ithaca: Cornell University, 1964.

3. Gregory, John W. A Study of the Impact of the Verbal Environment in Mathematics Classrooms on Seventh Grade Students' Logical Abilities. U.S.O.E. Cooperative Research Project 2-E-012, 1972, (ED 064 178).

4. Rosenshine, Barak. Objectively Measured Behavioral Predictors of Effectiveness in Explaining. Paper presented at the annual meeting of the American Educational Research Association, Chicago: 1968.

5. Smith, B. Othanel and Menx, Milton. A Study of the Logic of Teaching. Urbana: University of Illinois, 1962.

6. Winer, B. J. Statistical Principles in Experimental Design. New York: McGraw-Hill, 1962.

APPENDICES

INTERVIEW PROCEDURES

Situate the chairs (and table) in order that the subject sits opposite the interviewer (not side by side).

Try to have the recorder and microphone out of sight but check to make sure that voices are recorded.

1. Load the cassette and push the rewind button until tape stops.
2. Push the record button just prior to admitting the subject.
3. Admit the subject and have him be seated.
4. Read the subjects name.
5. Conduct the interview (See below).
6. Initial the pass and indicate the time.
7. Give pass to the subject and excuse.
8. Remove the cassette and write down the ID number on the cassette.
9. Turn the cassette over (or get new one) and start the cycle again.

INTERVIEW FORMAT

The interview format consists of four parts: questions without pictures, questions with a picture, rule generalization from manipulatives, and retelling a story. Each part is cescribed below separately. Try to adhere to the exact wording as much as possible. Capitals refer to what you should say; small (lower case) letters refer to what you should be doing.

__(subject's name)__ MY NAME IS _____. I'M GOING TO ASK YOU SOME QUESTIONS TO GET YOUR OPINION ON SOME THINGS. THERE ARE NO CORRECT ANSWERS SO JUST TELL ME WHAT YOU THINK. O.K.?

If the subject asks the purpose simply inform him that you are conducting a survey of opinions of students.

HERE'S THE FIRST QUESTION.

> WHY IS IT BETTER TO PUT CRIMINALS IN PRISON THAN TO LET THEM GO FREE?
>
> (Wait for subject to respond. Partial responses should be persued by prompting. "Fine, but can you explain a little more.")

O.K. HERE'S ANOTHER QUESTION.

WHY SHOULD A PERSON KEEP A PROMISE?

(Wait and/or prompt until an acceptable answer is given.)

FINE. NOW CAN YOU TELL ME,

WHAT'S YOUR OPINION ABOUT BOYS WITH LONG HAIR?

(Wait and/or prompt.)

ALL RIGHT. WHY DO YOU THINK WOMEN AND CHILDREN ARE THE FIRST PEOPLE TO BE SAVED WHEN A SHIP BEGINS TO SINK?

(Wait, etc.)

O.K. (Show the picture to the student and point to the parts as you describe them.)

HERE'S A BULL, (point) HERE'S A BOY, HERE'S A ROPE, HERE'S A HEAVY WEIGHT, AND HERE'S A LITTLE GIRL PICKING FLOWERS. (Pause.)

WHAT DO YOU THINK MIGHT HAPPEN?

(If the subject responds excluding one of the elements, Bull, Boy, Weight or Girl, then you should probe... WHAT WOULD HAPPEN TO THE BULL THEN? WHAT ABOUT THE BOY? WHAT ELSE MIGHT HAPPEN?)

O.K. FINE. NOW I'M GOING TO SHOW YOU SOME ORANGE CARDS AND SOME GREEN CARDS. THERE IS A SQUARE OR A CIRCLE ON THE OTHER SIDE. I WANT YOU TO GUESS WHAT"S ON THE OTHER SIDE, A CIRCLE OR A SQUARE.

(Show the orange card and say:)

WHAT DO YOU THINK IS ON THE OTHER SIDE, A CIRCLE OR A SQUARE?

(Subject guesses. Turn over the card.)

WHAT DO YOU THINK IS ON THE OTHER SIDE OF THIS CARD?

(Show the green card.)

O.K. CAN YOU STATE A RULE FOR FINDING THE CIRCLE AND THE SQUARE?

(Wait for response.)

O.K. WHAT SHOULD BE ON THE OTHER SIDE OF THIS ONE?

(Show the next orange card, and wait.)

O.K. IS IT THE SAME RULE?

(If student says yes: WHAT WAS THE RULE AGAIN?)

(If student says no: WELL WHAT IS THE RULE?)

O.K. AND ON THE OTHER SIDE OF THIS ONE THERE'S A WHAT?

(Show the green one. Wait.)

O.K. SO THE RULE FOR FINDING THE SQUARE AND THE CIRCLE IS WHAT, AGAIN?

(If student still doesn't have the rule, pick up the cards and go through it again, requesting the rule after each card presentation.)

NOW I'M GOING TO SHOW YOU SOME MORE CARDS. THESE ARE BLUE AND RED AND THEY HAVE A LETTER ON THE FRONT OF THEM. I WANT YOU TO DO THE SAME THING, GUESS WHAT'S ON THE OTHER SIDE, EITHER A SQUARE OR A CIRCLE. (Show the red A.) WHAT DO YOU THINK IS ON THE OTHER SIDE A SQUARE OR A CIRCLE?

(Wait.)

O.K. HOW ABOUT THIS ONE? (Show the blue B.)

(Wait.)

O.K. WHAT'S THE RULE FOR FINDING THE SQUARE AND THE CIRCLE?

(Allow the student to elicite the rule.)

THEREFORE, WHAT DO YOU THINK IS ON THE BACK OF THIS ONE?

(Show the blue A and wait.)

IS THE RULE WORKING? (Wait.) WHAT'S THE RULE NOW? (Wait.)

O.K. THEN WHAT IS ON THE OTHER SIDE OF THIS ONE?

(Show the red B.)

SO THE RULE FOR FINDING THE CIRCLE AND THE SQUARE IS WHAT?

(Wait. If the student doesn't have the rule, pick up the cards again and go through the same procedure, asking for the rule after each card presentation and guess.)

YOU'VE BEEN DOING REAL WELL. THIS TIME I'M GOING TO READ A SHORT STORY TO YOU. I WANT YOU TO LISTEN CAREFULLY AS I READ IT BECAUSE I WANT YOU TO TELL THE STORY TO ME WHEN I FINISH. O.K.? (DO YOU UNDERSTAND THE DIRECTIONS?)

(Read the story without reading the title.)

O.K. NOW TELL ME THE STORY ABOUT DUGGY AND BUGGY.

(Let the subject tell the story back to you without you assisting in any way. Don't interrupt. If he asks a question of fact give a short answer.)

GOOD. WE'RE FINISHED. LET ME FILL OUT YOUR PASS AND LET YOU GET BACK TO CLASS. TRY NOT TO TALK ABOUT OUR INTERVIEW WITH YOUR FRIENDS BECAUSE WE WANT IT TO BE A SURPRISE FOR THEM WHEN THEY COME SEE ME. O.K.? (Fill out the pass and dismiss the subject.)

DUGGY AND BUGGY

Two flies, Duggy and Buggy, were sitting on the handle of a lawnmower talking.

Duggy said, "If I don't get something to eat, I'm going to die."

Buggy replied, "We can go fly around the trash cans to look for food, if you want to."

"But the garbage man came today," said Duggy. "And you know if the new man was on duty today then there won't be any food left."

"Well we could fly over to the other side of the house, go through the window, and eat the crumbs on the table," suggested Buggy.

"But there are too many clouds in the sky," said Duggy.

"Clouds in the sky? What difference does that make?" exclaimed Buggy.

"Well you know that if it even looks like rain, then the lady closes the windows. We won't be able to get in," explained Duggy.

Just then a meat truck drove by. It went around the corner too fast and a roll of baloney fell off. Duggy and Buggy just sat there on the handle looking at it. Then Buggy said, "Hey, let's go eat that baloney!!"

"But what will happen to us if the dog comes out?" asked Duggy.

"Look, if the dog comes out, then he'll eat all the baloney. And if that happens, we won't get anything to eat," replied Buggy.

"OK, if you think we should then let's go eat the baloney." And with that, they flew over and began eating.

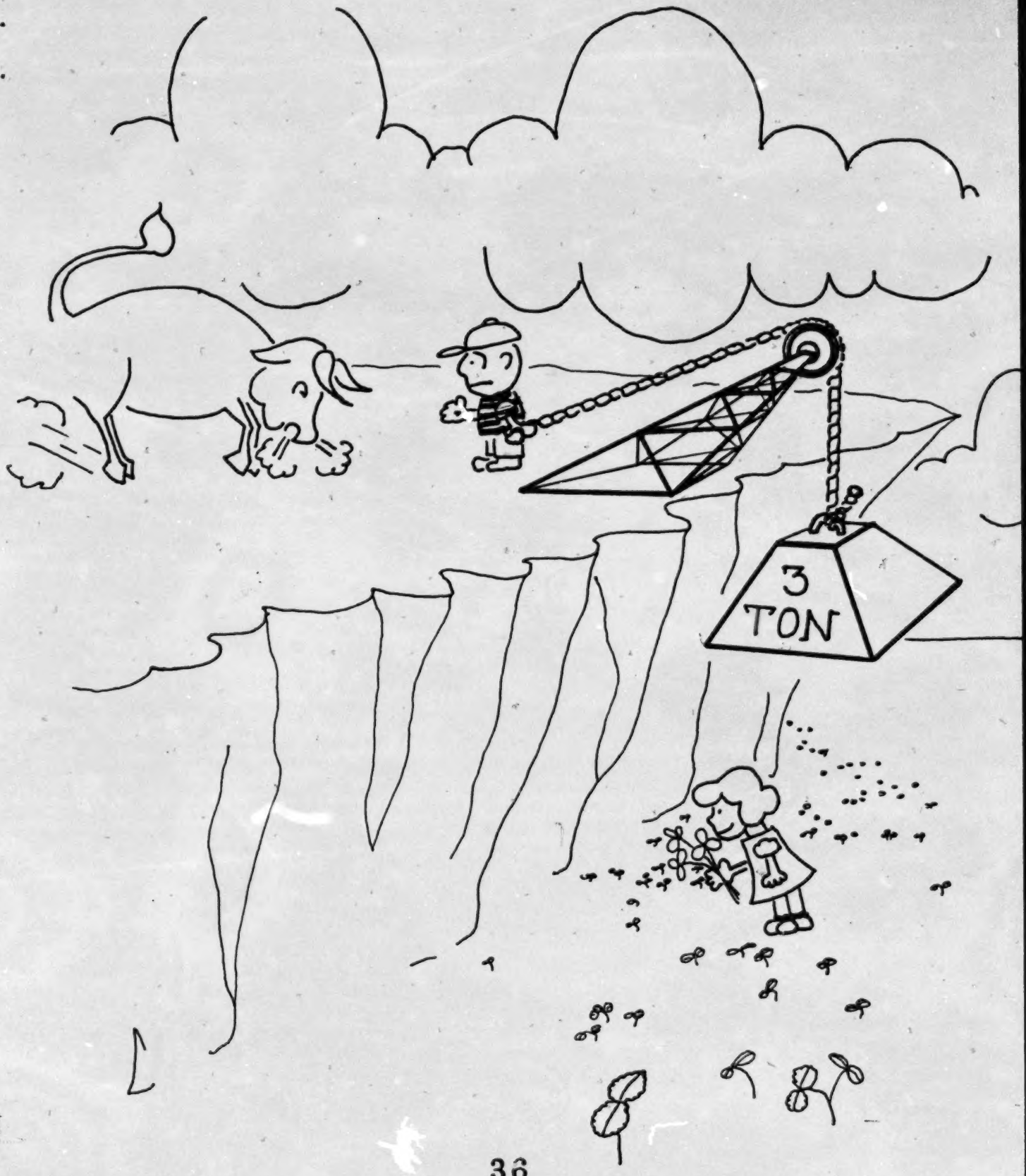
Just as they were starting to eat, the dog came out. He ran over to the baloney and said, "If you guys don't get out of here, you're going to get hurt." And the flies flew back to the handle of the lawnmower.

Duggy said, "Gee, is he mean. If we hadn't left he would have killed us for sure."

"Yeh, but maybe if we wait long enough he'll go away," replied Buggy. So they waited and sure enough the dog went away.

Buggy was the first to notice that the dog had left. "If we hurry right now, we can get some more baloney to eat," hollered Buggy. And off they went to eat more baloney. They ate, and ate, and ate, and ate until all the baloney was gone. They had just enough energy left to fly back to the handle of the lawnmower and Buggy said, "Man, was that good! If we eat like that just once a week, we won't have to worry about starving."

Duggy complained that he was getting dizzy. "I'm feeling sick. If I'm not careful I'll fall off this handle." Buggy replied, "If you fall off the handle, you'll probably die when you hit the ground. Let's fly over to that table and rest." They flew off the handle and both of them were so full they fell to the ground -- splat!! -- and died. So the lesson is don't fly off the handle if you're full of baloney.


3
TON